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Proni

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(54) **LOUDSPEAKER SYSTEM WITH PASSIVE RADIATOR**

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| ***H04R 1/28*** | (2006.01) |
| ***H04R 9/06*** | (2006.01) |

(52) **U.S. Cl.**

CPC ........... ***H04R 1/2834*** (2013.01); ***H04R 9/063*** (2013.01)

(58) **Field of Classification Search**

CPC combination set(s) only.
See application file for complete search history.

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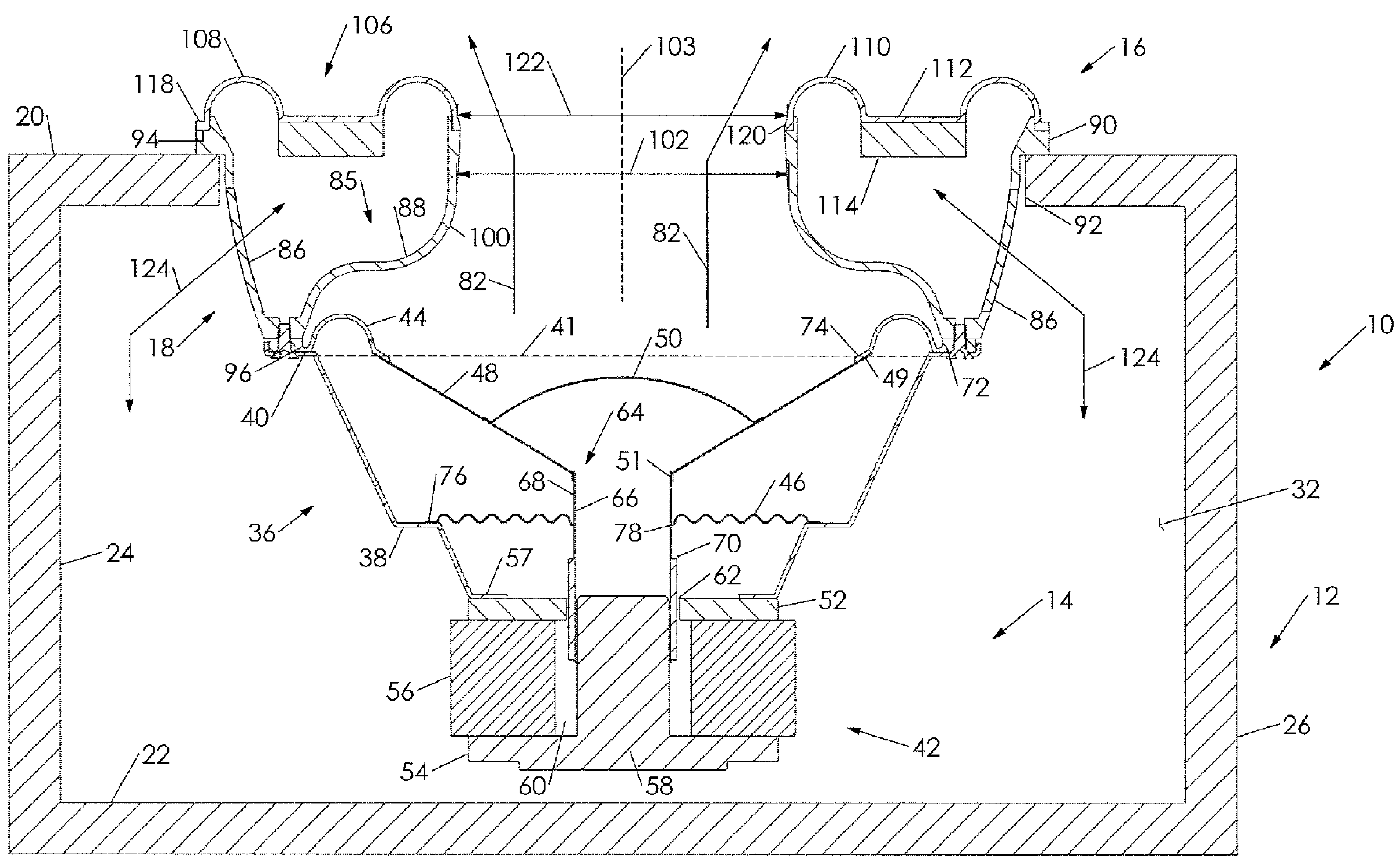
(57) **ABSTRACT**

A loudspeaker system is provided in which a passive radiator and a driver are connected to one another within a speaker enclosure by an acoustic coupler having a coupler opening such that the driver and the passive radiator are located in different planes.

**30 Claims, 8 Drawing Sheets**



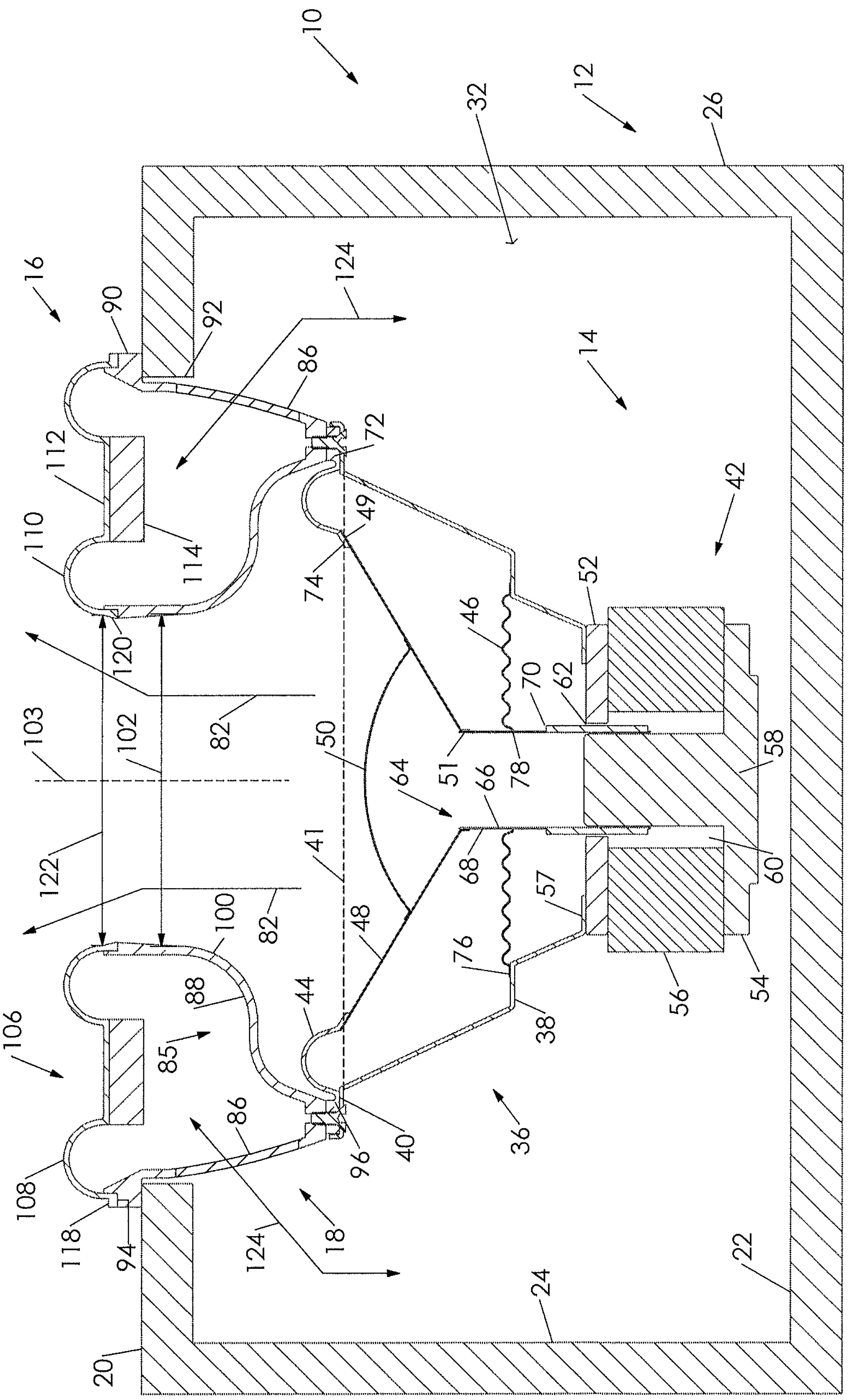

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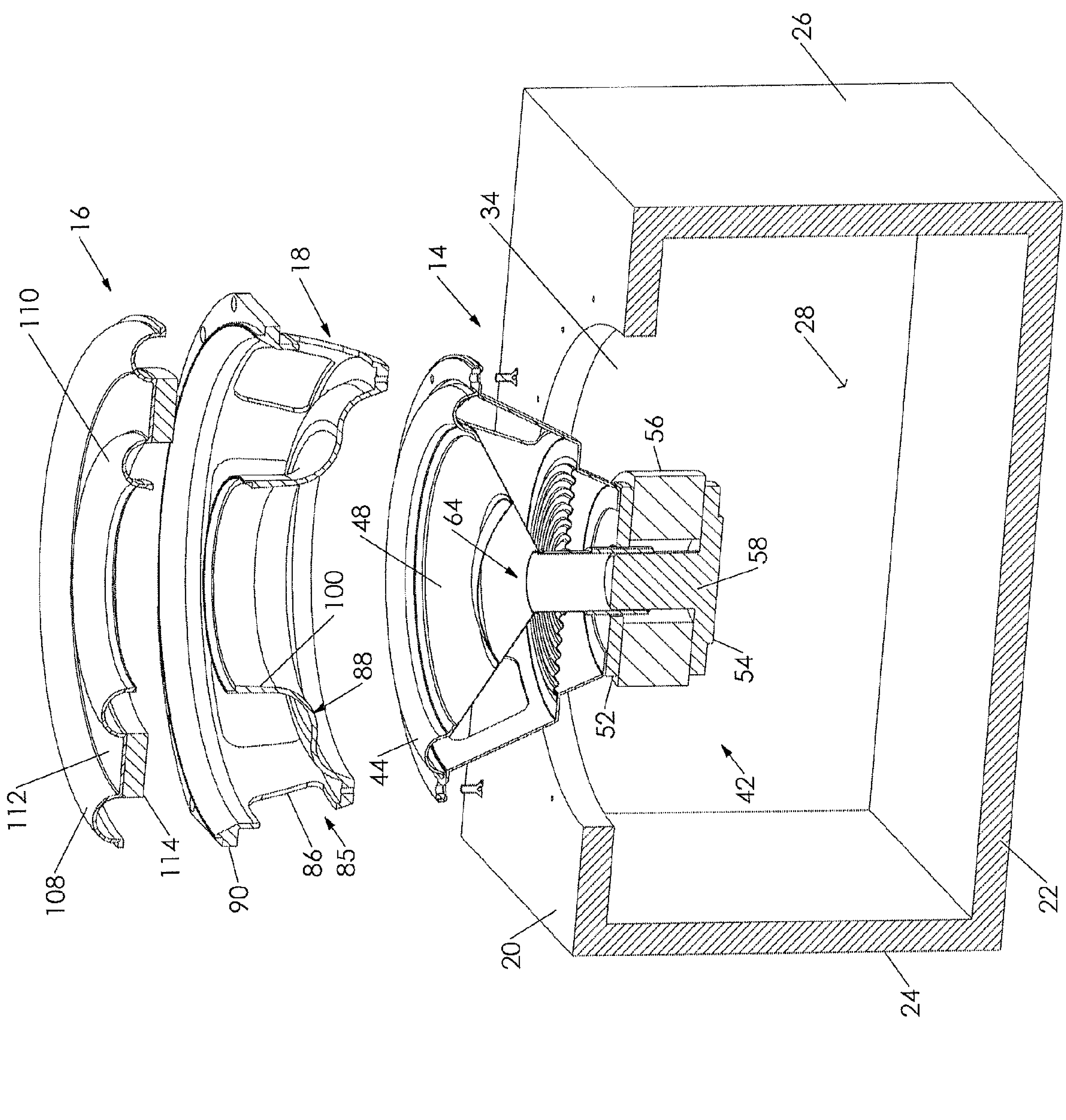
FIG. 1

FIG. 2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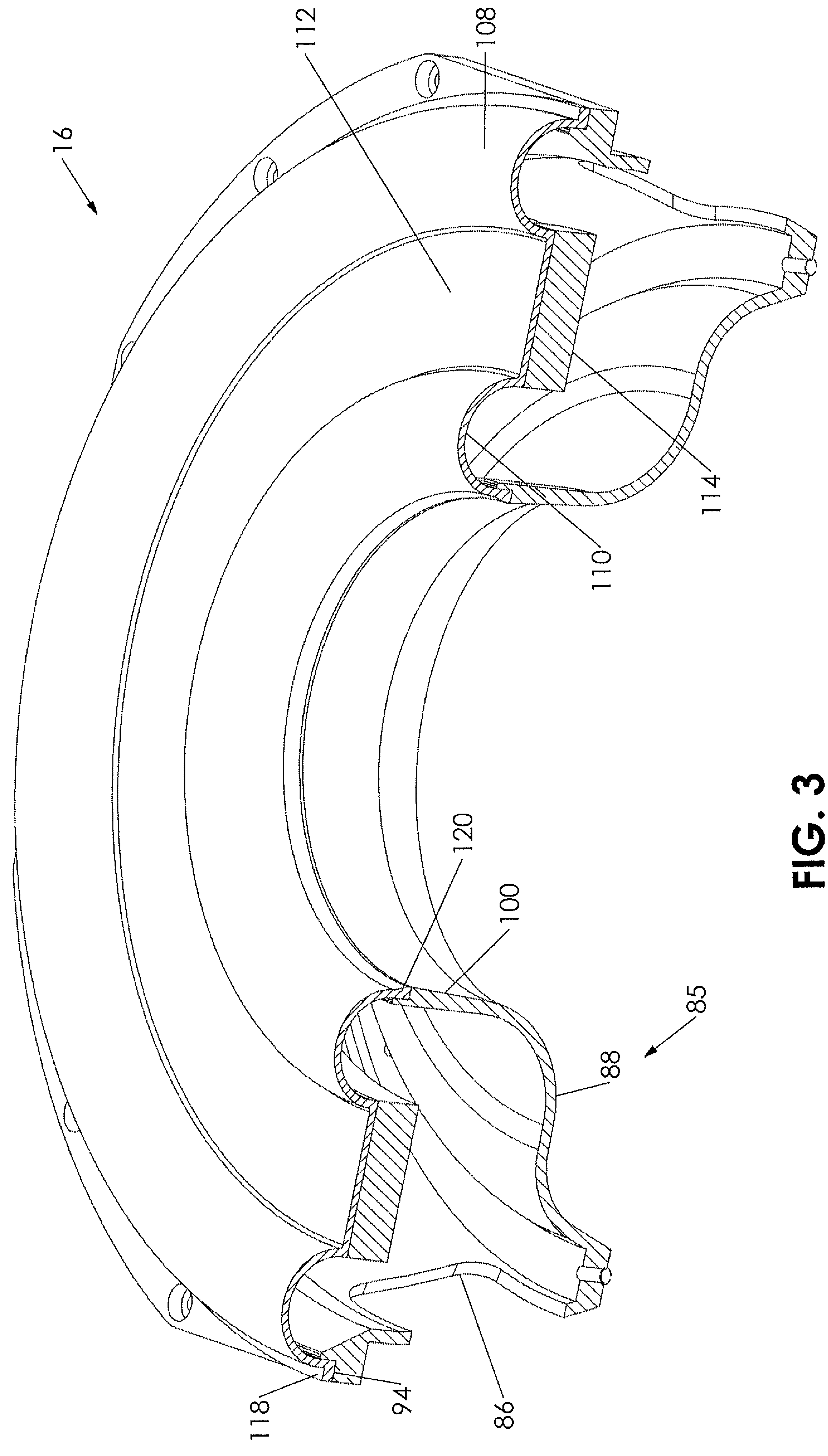



FIG. 3

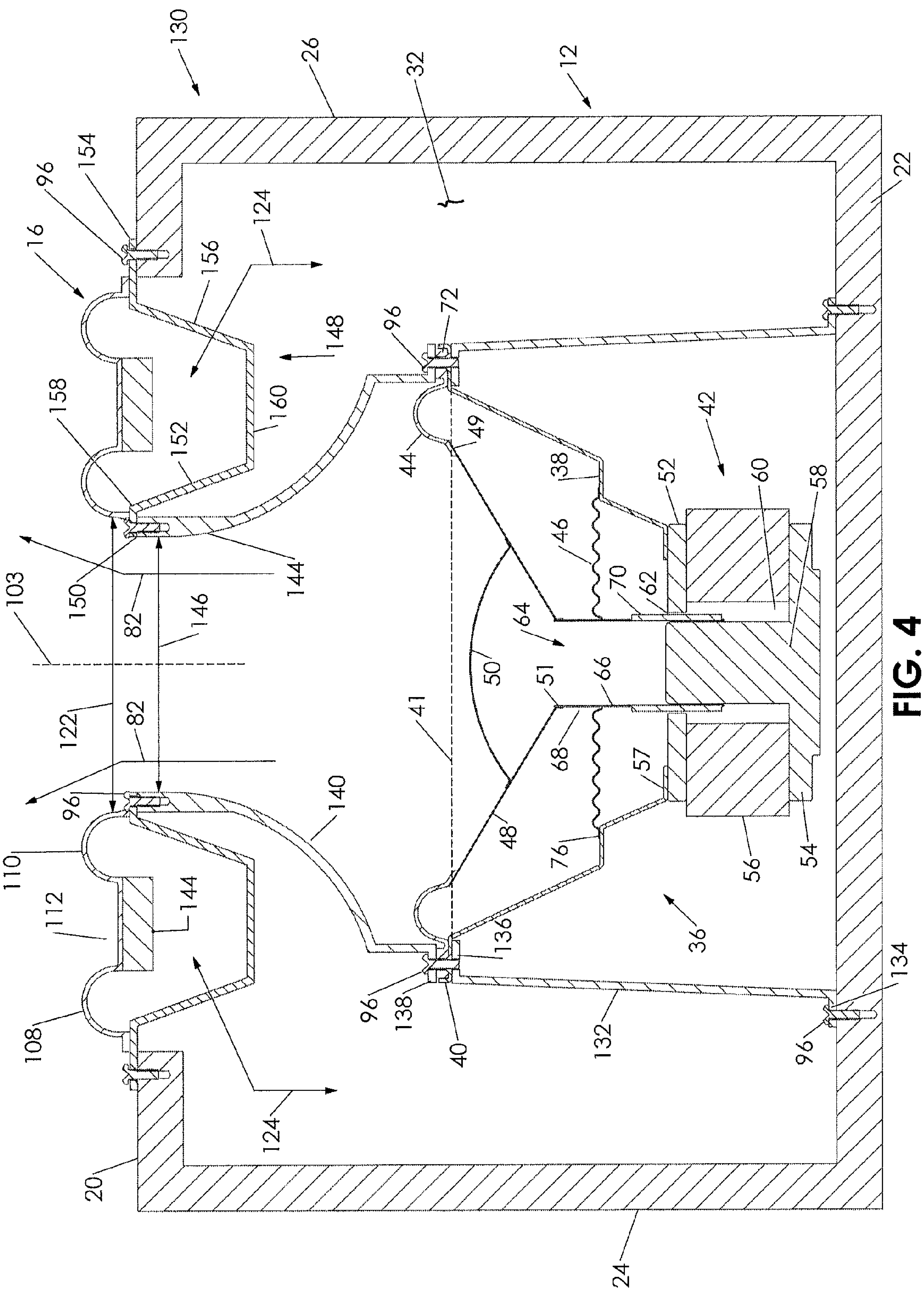
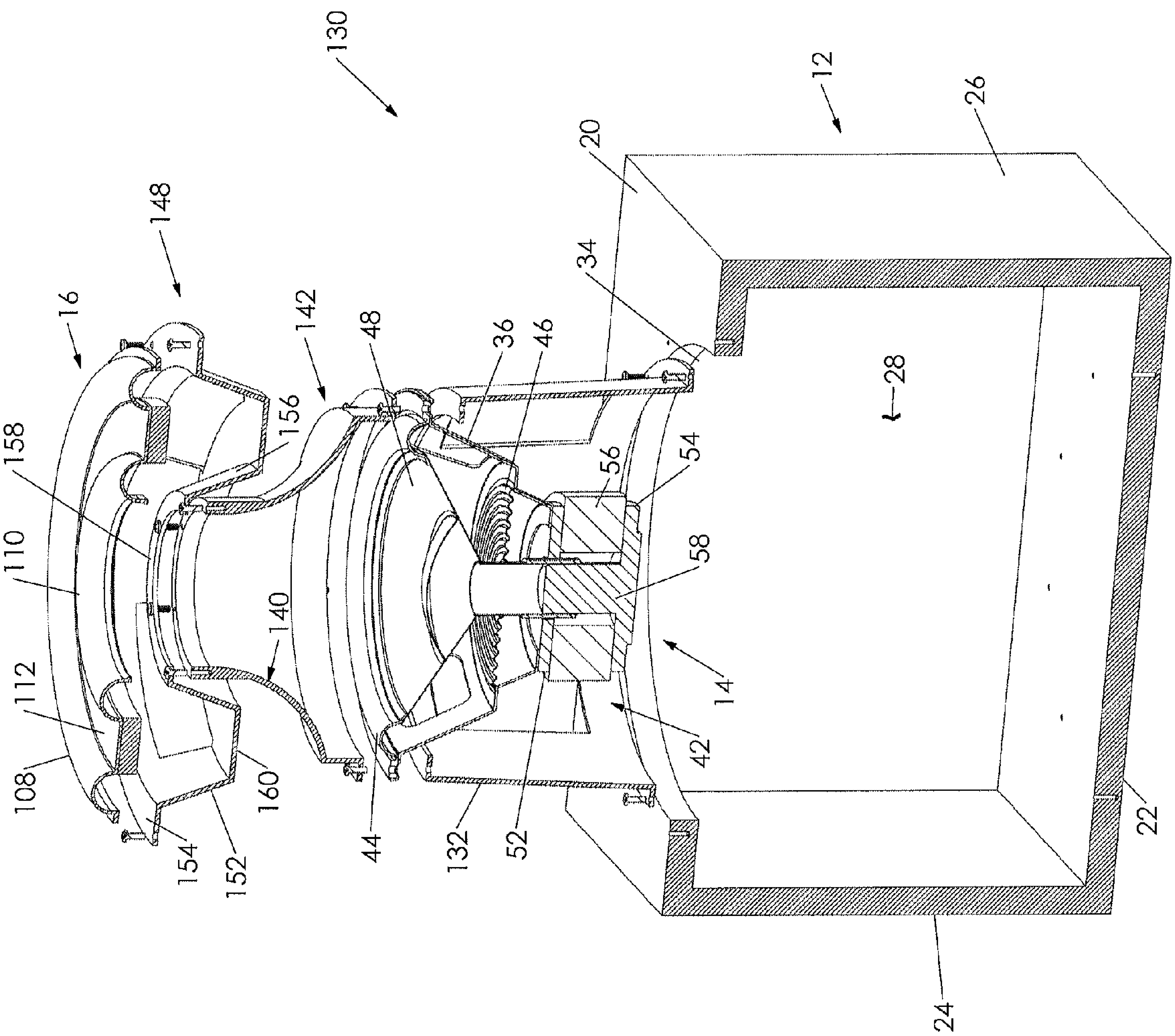


FIG. 4

FIG. 5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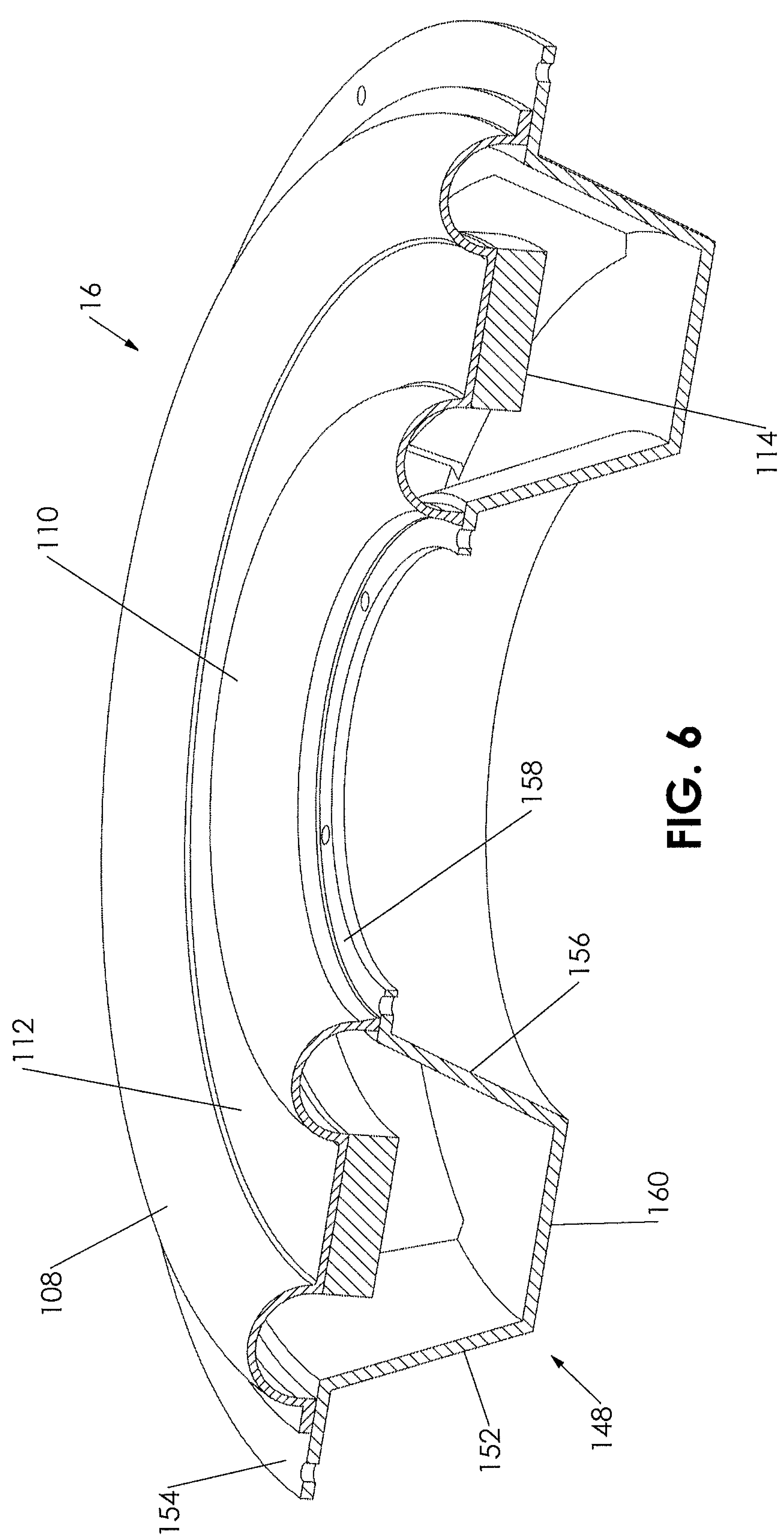


FIG. 6

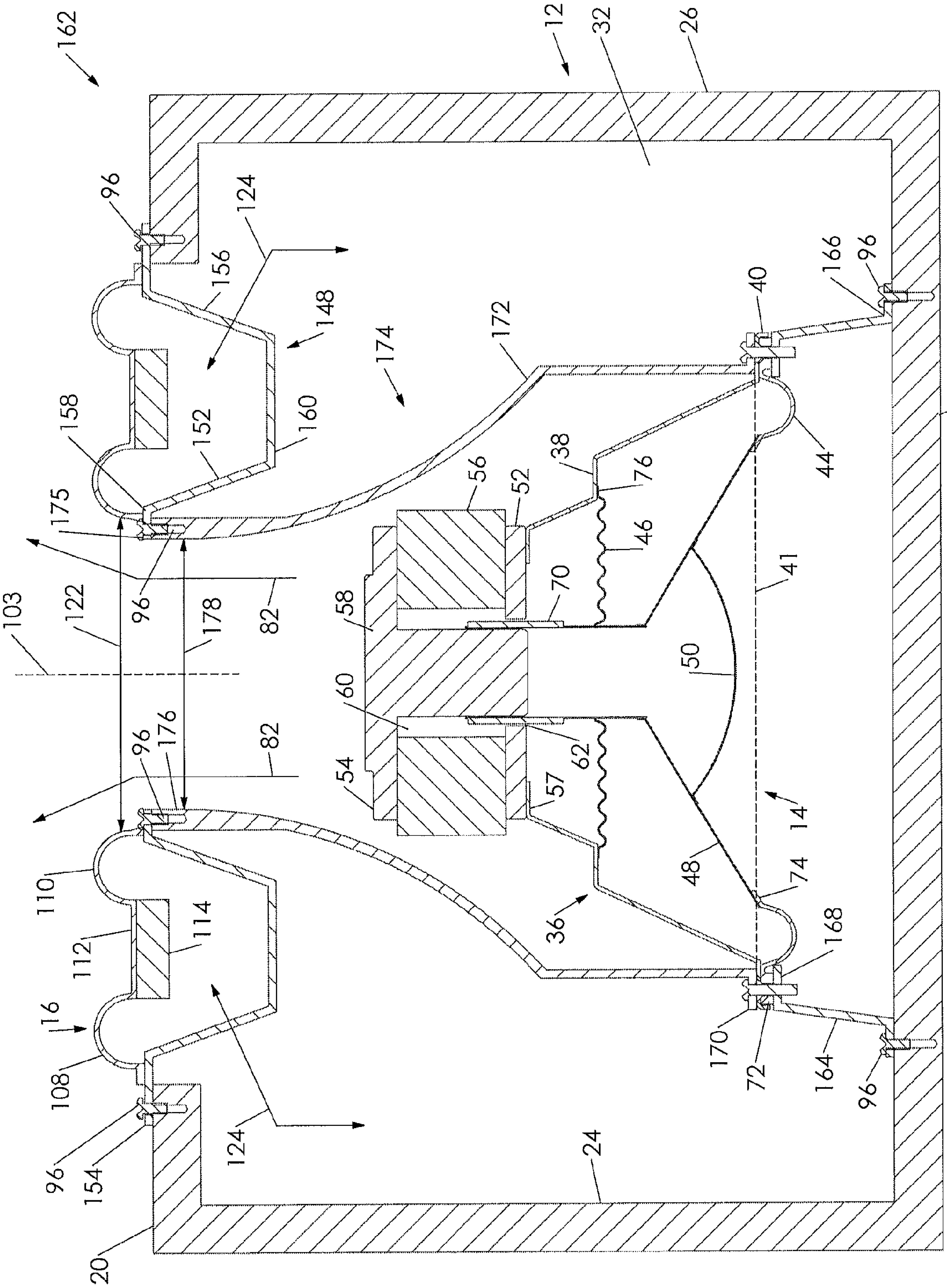
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FIG. 7

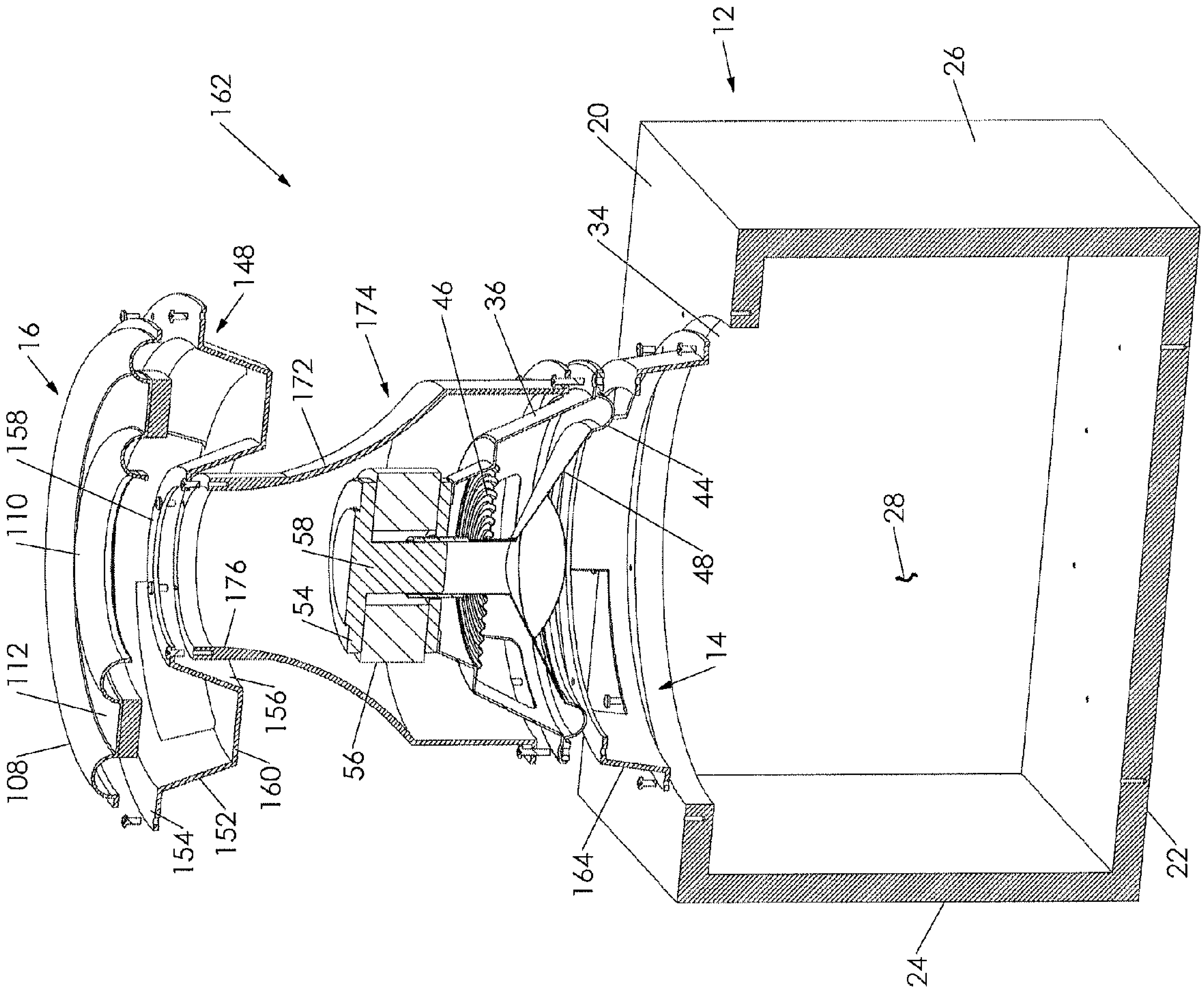
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FIG. 8

# LOUDSPEAKER SYSTEM WITH PASSIVE RADIATOR

## FIELD OF THE INVENTION

This invention relates to loudspeakers, and, more particularly, to a loudspeaker system including an acoustic coupler connected between a driver and a passive radiator wherein a coupler opening area of the acoustic coupler is less than or equal to the mounting area of the driver.

## BACKGROUND OF THE INVENTION

Loudspeaker systems generally include an enclosure having an interior within which a driver is mounted in alignment with an opening formed in the front panel of an enclosure. In order to reinforce the low frequency output of the loudspeaker system, it is common to employ a port or a passive radiator in the speaker enclosure. Ports and passive radiators resonate at low frequencies, typically lower than that of the driver/enclosure system, and therefore enhance reproduction of low frequencies produced by the driver. In most cases, a ported or passive radiator speaker system has a wider low frequency bandwidth than a sealed-enclosure design.

A port is essentially a tube having a length dimension, or distance between its opposite ends, wherein one end is typically located at the front panel of the enclosure and the opposite end is positioned within the interior of the speaker enclosure. To maintain system linearity at very low frequencies, the cross sectional area of the port must be large. Further, a large cross sectional area is required when using ports to avoid "chuffing" or air flow noises. Ports with a large cross sectional area must be longer than small area ports in order to be tuned to the same low frequency. In applications where the speaker enclosure must be relatively small, such as subwoofer speaker systems designed for use in vehicles, it is not possible to use long, low-frequency ports due to space considerations. The speaker enclosure must house both the driver and the port, which requires a relatively large volume box. If the ports are designed with a smaller cross sectional area in an attempt to overcome the space issue, unacceptable air flow noises would result. On the other hand, tuning a port for higher frequencies, which allows it to be shortened and take up less space, sacrifices the desired system frequency response.

Passive radiators solve some of the issues with ports noted above because their length dimension may be much less than that of tubes and they may take up less volume in the interior of the speaker enclosure. One typical form of passive radiator resembles a driver, i.e. it includes upper and lower suspensions and a diaphragm, but the motor structure of the driver is eliminated. When mounted in a speaker enclosure, internal air pressure generated by axial movement of the driver creates air pressure waves that cause the passive radiator to move. Like ports, passive radiators resonate at a frequency lower than that of the driver/enclosure system. System linearity at very low frequencies is obtained with a passive radiator by making its radiating area, e.g. the surface of the diaphragm in the example given above, relatively large compared to that of the driver itself. While the length dimension of passive radiators may be made more compact than ports, the large radiating area requirement creates the need for a larger surface area at the baffle of the enclosure or the use of multiple enclosure faces. Such surface area may amount to the equivalent of two drivers or more since the radiating area of the passive radiator is larger than that of the diaphragm of the driver. Consequently, the overall dimension of the speaker enclosure needed when using a passive radiator may be greater than the area which is available in a given application. This is particularly true in the case of loudspeaker systems for use in vehicles wherein only one wall of the enclosure may be exposed for use as a radiating surface and/or if the total radiating area is small due to space constraints.



## SUMMARY OF THE INVENTION

This invention is directed to a loudspeaker system in which a passive radiator and a driver are connected to one another within a speaker enclosure by an acoustic coupler such that the driver and passive radiator are located in different planes. Further, the acoustic coupler is formed with a coupler opening area which is less than or equal to the mounting area of the driver.

In the presently preferred embodiment, the driver of the loudspeaker system comprises a frame, a motor structure, an upper suspension, a lower suspension and a diaphragm extending between the motor structure and upper suspension. The speaker enclosure is formed with a number of interconnected panels defining an interior which is closed except for an opening in the front panel of the enclosure. In one aspect of this invention, the passive radiator and driver are mounted relative to one another in such a way as to reduce the overall dimensions of the speaker enclosure. Preferably, the passive radiator is connected to the front panel of the speaker enclosure at its opening. The mounting structure of the driver, discussed below, is located within the enclosure interior in a plane that is spaced from the front panel and the passive radiator. The driver and passive radiator are preferably concentric to one another, but may be linearly offset and/or angularly offset, as described below.

In another aspect of this invention, the acoustic coupler preferably includes a wall having a generally annular portion defining a coupler opening area. The mounting structure of the driver has a mounting diameter defining a mounting area as described below. Preferably, the coupler opening area of the acoustic coupler is less than or equal to the mounting area of the driver. In fact, the ratio between the mounting area and coupler opening area may be three-to-one or higher, e.g. the mounting area can be three times as large as the coupler opening area, or more, without sacrificing the performance of the loudspeaker system or producing objectionable air noises.

In operation, excursion of the motor structure of the driver generates air pressure waves within the interior of the enclosure which impact the passive radiator causing it to resonant at a frequency lower than that of the driver/enclosure system. The sound output from the driver is transmitted through the annular portion of the wall of the acoustic coupler where it is accelerated without creating unwanted air noise. Because the driver and passive radiator are located in different planes when mounted to the speaker enclosure, a substantial amount of baffle or panel space is saved compared to prior art systems in which the passive radiator and driver are mounted side-by-side. This is an important advantage in applications such as loudspeaker systems for vehicles wherein space is limited and only one surface of the enclosure may be available for radiation of the sound output from the driver.

## DESCRIPTION OF THE DRAWINGS

The structure, operation and advantages of the presently preferred embodiment of this invention will become further apparent upon consideration of the following description, taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a cross sectional view of the loudspeaker system of this invention;

FIG. **2** is an exploded perspective view, in partial cross section, of the loudspeaker system depicted in FIG. **1**;

FIG. **3** is a perspective view of a portion of FIG. **2** showing the passive radiator and acoustic coupler connected to one another as an integrated unit;

FIG. **4** is a cross sectional view of an alternative embodiment of a loudspeaker system according to this invention;

FIG. **5** is an exploded perspective view, in partial cross section, of the loudspeaker system illustrated in FIG. **4**;

FIG. **6** is a perspective view of a portion of FIG. **5** depicting a passive radiator mounted to an connector frame;

FIG. **7** is a cross sectional view of a still further embodiment of a loudspeaker system according to this invention; and

FIG. **8** is an exploded perspective view, in partial cross section, of the loudspeaker system illustrated in FIG. **7**.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring initially to FIGS. **1**-**3**, one embodiment of a loudspeaker system **10** is illustrated which comprises a speaker enclosure **12**, a driver **14**, a passive radiator **16** and an acoustic coupler **18**. For purposes of the present discussion, the terms "upwardly," "downwardly," "upper," "lower," "top," "bottom," "vertical" and horizontal" refer to vertical relationships of the elements of system **10** in the orientation that is depicted in the drawings, and the terms "inner," "outer," "inwardly" and "outwardly" refer to radial relationships of the system **10** elements in the orientation illustrated in the Figs.

The loudspeaker enclosure **12** includes a front panel **20**, a back panel **22**, opposed side panels **24**, **26**, and, opposed end panels **28**, one of which is shown in FIG. **2**. The panels **20**-**28** are interconnected to form a hollow interior **32**. The interior **32** is closed except for a panel opening **34** formed in the front panel **20**. While the opening **34** is depicted as circular in FIG. **2**, it should be understood that such opening **34** could be oval, square or essentially any other shape.

The driver **14** comprises a frame **36** having a lower seat **38** and an upper flange **40**, a motor structure **42**, an upper suspension **44**, a lower suspension **46**, a diaphragm **48** and a dust cap **50**. The motor structure **42** includes a top plate **52** and a back plate **54** which are spaced from one another and mount a permanent magnet **56** between them. A lower end **57** of the frame **36** is mounted to the top plate **52** by adhesive, fasteners or other suitable means. A pole piece **58** is integrally formed with and extends upwardly from the back plate **54** into a central bore **60** formed in both the magnet **56** and the top plate **52**. A magnetic gap **62** is formed between the top plate **52** and the pole piece **58**. A voice coil **64** is located in the magnetic gap **62**. It comprises a hollow, cylindrical-shaped former **66** having an outer surface **68** which mounts a wire winding **70**. The former **66** is concentrically disposed about the pole piece **58** such that the voice coil **64** is axially movable within the magnetic gap **62** during operation of the driver **14**.

The voice coil **64** is held in place relative to the pole piece **58** by the upper suspension **44**, lower suspension **46** and diaphragm **48**. An outer edge **72** of the upper suspension **44** is connected to the flange **40** of the frame **36**, and its inner edge **74** is connected to the upper end **49** of the diaphragm **48**. The lower end **51** of diaphragm **48** mounts to the outer surface **68** of former **66**. An outer edge **76** of the lower suspension **46** is connected to the lower seat **38** of frame **36**, and its inner edge **78** mounts to the former **66** at a point below where the diaphragm **48** is connected. The dust cap **50** is mounted to the diaphragm **48** in position to overlie the voice coil **64** and pole piece **58** in order to protect such elements from dirt, dust and other contaminants. In response to the input of electrical energy to the wire winding **70**, the voice coil **64** is moved axially within the magnetic gap **62**. Since the diaphragm **48** is operatively connected to the voice coil **64**, it deflects and moves with the excursion of the voice coil **64** producing sound waves that radiate in a direction depicted by the arrows **82** in FIG. **1**.

As used herein, the following terms are considered to have the specific meanings given below. The term "mounting structure" refers to the flange **40** of the driver frame **36** which is employed to mount the driver **14** within the interior **32** of the speaker enclosure **12**. The flange **40** is depicted in the Figs. as an annular member that extends around the entirety of frame **36**. In some loudspeaker system designs, a flange such as flange **40** may be replaced by discrete tabs spaced about speaker frame at intervals from one another. Such arrangement, and similar variations, are nevertheless considered "mounting structure" for purposes of this invention.

The term "mounting diameter" in the embodiments illustrated in the drawings refers to the diameter of the mounting structure of the driver **14**, e.g. the flange **40** of frame **32**, which is circular in shape. It should be understood, however, that the frames of drivers may be fabricated in shapes other than circular, such as oval, square or other shapes. Consequently, the terms "mounting diameter" generally and "diameter" in particular are expressly not limited to the diameter of a circle but are meant to encompass any other symmetrical and non-symmetrical shapes. As such, "mounting diameter" is considered to comprise the largest transverse dimension of a particular shape. Further, as noted above, the mounting flange of a particular driver such as flange **40** of frame **32** may be replaced by spaced tabs of other mounting structure. The "mounting diameter" of those structures is therefore considered to be the largest transverse dimension between such spaced tabs or the like.

The term "mounting area" refers to the area circumscribed by the mounting structure of a driver of given shape having a particular mounting diameter. For example, in the case of the circular flange **40** of frame **32**, the "mounting area" is considered to be the area circumscribed by such circular flange **40**. The mounting area of a square driver, an oval driver or some other shape is considered to be the area circumscribed by those shapes, each having a mounting structure with a mounting diameter.

The driver **14** is mounted within the interior **32** of the enclosure **12** by the acoustic coupler **18** such that the mounting structure or flange **40** of the driver **14** is preferably generally concentric to and vertically spaced from the panel opening **34** in the front panel **20** of enclosure **12**. The acoustic coupler **18** is preferably, although not necessarily, formed in a one-piece cast or stamped construction comprising a wall **85** having an outer section **86** joined to an inner section **88**. The upper end **90** of the outer section **86** is mounted by fasteners (not shown) to the front wall **20** of enclosure **12** at the peripheral edge **92** of the panel opening **34** in the front panel **20**. A seat **94** is formed in the upper end **90** for mounting the passive radiator **16**, as described below. The juncture of the outer and inner sections **88**, **86** of the wall **85** of acoustic coupler **18** rests atop the flange **40** formed in the frame **36** of driver **14** where it is attached thereto by fasteners **96**.

In the presently preferred embodiment, the inner section **88** of the acoustic coupler **18** a mouth or annular portion **100** which forms a coupler opening **102** denoted in FIG. **1** by a horizontal line spanning the annular portion **100**. As illustrated in FIG. **1**, the annular portion **100** of inner section **88** is substantially vertically oriented and the coupler opening **102** it defines is preferably generally concentrically disposed relative to the panel opening **34** in the front panel **20** of enclosure **12** and relative to the flange **40** of the driver **14**. For purposes of the present discussion, the cross sectional area of the coupler opening **102** defined by the annular portion **100** of inner section **88** is referred to herein as the "coupler opening area" of the loudspeaker system **10**.

The passive radiator **16** of loudspeaker system **10** comprises a double surround **106** having an outer roll **108** and an inner roll **110** joined together by a ring **112**. The ring **112**, outer roll **108** and inner roll **110** may be circular, square, rectangular, oval or essentially any other shape. A tuning block **114** may be mounted along an inner surface **116** of the ring **112**, or, alternatively, directly to one or both of the outer roll **108** and inner roll **110**. The tuning block **114** may be formed of plastic, wood or other material whose mass may be varied to tune the frequency at which the passive radiator **16** resonates, as is well known in the art. An outer edge **118** of the outer roll **108** is preferably affixed to the seat **94** formed in the outer section **86** of acoustic coupler **18**, and an inner edge **120** of the inner roll **110** is connected at the top of the annular portion **100** of the inner section **88** of acoustic coupler **18**. The mouth **122** of the passive radiator **16**, foiled by the inner roll **110** and depicted by a horizontal line in FIG. **1**, is preferably generally concentrically disposed relative to the panel opening **34** in the enclosure **12**, to the coupler opening **102** of the acoustic coupler **18** and to the flange **40** of the driver **14**.

With respect to the phrase "generally concentric" used above, it is contemplated that the loudspeaker system **10** will function as intended in the event of some lateral and/or angular offset between the driver **14**, passive radiator **16** and acoustic coupler. As viewed in FIG. **1**, the term "lateral" refers to a side-to-side direction between the side panels **24**, **26**, or an end-to-end direction between the end panels **28**. The term "angular" refers to an angle measured relative to a vertical axis **103** passing through the center of the passive radiator **16**. In a preferred embodiment of this invention, the driver **14**, passive radiator **16** and acoustic coupler **18** are concentric to one another, e.g. the central axis of each is substantially coincident with axis **103**. The central axis of acoustic coupler **18** is coincident with an axis passing through the center of its annular portion **100**, and the central axis of the driver **14** passes through the center of pole piece **58**. The term "generally concentric" is intended to describe the positional relationship between the driver **14**, passive radiator **16** and acoustic coupler **18** in which such components are not exactly concentric. In particular, the central axes of the driver **14** and passive radiator **16** may be laterally offset from one another by an amount within up to one mounting diameter of the driver **14**, and angularly offset by 10° or more, and still be considered "generally concentric" for purposes of this invention.

One aspect of this invention is predicated on the concept of orienting the passive radiator **16**, acoustic coupler **18** and driver **14** relative to one another such that the dimensions of the speaker enclosure **12** may be reduced compared to prior art systems. This is particularly advantageous in applications such as vehicle sound systems, for example, in which space is limited. With reference to FIG. **1**, as noted above the driver **14** is mounted by the acoustic coupler **18** in a position vertically below the passive radiator **16**. For purposes of the present discussion, the mounting structure or flange **40** of the driver **14** is considered to lie within a plane depicted by the line **41** shown in FIG. **1**. The plane **41** is horizontally disposed as illustrated in the drawings but could assume any orientation depending upon how the loudspeaker system **10** is installed in a particular application. The mounting structure or flange **40** of driver **14**, and, hence, plane **41**, are therefore spaced from the front panel **20** of the speaker enclosure **12** and from the passive radiator **16** connected to the front panel **20**. The fact that the driver **14** and passive radiator **16** lie in different planes, rather than side-by-side along the front panel as in many prior art designs, significantly reduces the space requirements of the loudspeaker system **10** and therefore allows the speaker enclosure **12** to be smaller in order to accommodate applications where space is limited.

In the operation of the loudspeaker system **10**, axial excursion of the voice coil **64** causes the diaphragm **48** to produce sound output which is directed toward the panel opening **34** in the enclosure **12**. See arrows **82**. In the course of movement with the voice coil **64**, the diaphragm **48** also produces air pressure waves, represented by the arrows **124** in FIG. **1**, which, in turn, causes the passive radiator **16** to move. As discussed above, the passive radiator **16** resonates at a lower frequency than the driver **14** and enclosure **12** system, and is effective to enhance the reproduction of low frequencies produced by the driver **14**.

Another aspect of this invention which allows the size of the speaker enclosure **12** to be reduced involves forming the coupler opening area of the acoustic coupler **18** equal to or smaller than the mounting area of the driver **14**. In fact, the mounting area may be three times the size of the coupler opening area, or more, without sacrificing the performance of the loudspeaker system **10** or creating undesirable air noise as the sound output of the driver **14** passes through the coupler opening **102** of the acoustic coupler **18**. The relatively smaller size of the coupler opening area allows the size of the panel opening **34** in the front panel **20** of enclosure **12** to be correspondingly reduced. As noted above, in applications such as vehicle sound systems in which space is limited, reduction in the overall size of the speaker enclosure **12** and its front panel **20** is highly advantageous.

Referring now to FIGS. **4-7**, an alternative embodiment of a loudspeaker system **130** according to this invention is illustrated. The loudspeaker system **130** employs the same speaker enclosure **12**, driver **14** and passive radiator **16** described above in connection with a discussion of the system **10** shown in FIGS. **1-3**, and therefore the same reference numbers are used in FIGS. **4-7** to denote like structure in such Figs. Further, the terms "mounting area," "mounting diameter," "mounting structure" and "generally concentric" defined above with reference to FIGS. **1-3** apply equally to the loudspeaker system **130**. The primary differences between loudspeaker systems **10** and **130** involve a somewhat different acoustic coupler and how the driver **14** is mounted within the speaker enclosure **12**.

Instead of suspending the driver **14** from an acoustic coupler **18** as depicted in FIGS. **1-3**, the driver **14** is connected to a support bracket **132** having a lower ring **134** and an upper ring **136**. The lower ring **134** of support bracket **132** is mounted by fasteners **96** to the back wall **22** of speaker enclosure **12**. The upper ring **136** supports the flange **40** of driver frame **36**, the outer edge **72** of upper suspension

**44** and the bottom end **138** of the wall **140** of an acoustic coupler **142**. The wall **140** has a mouth or annular portion **144** which forms a coupler opening **146** denoted in FIG. **4** by a horizontal line spanning the annular portion **144**. The annular portion **144** is substantially vertically oriented and the coupler opening **146** it defines is preferably generally concentrically disposed relative to the panel opening **34** in the front panel **20** of enclosure **12** and relative to the mounting structure or flange **40** of the driver **14**. The cross sectional area of the coupler opening **146** defined by its annular portion **144** comprises the "coupler opening area" of the loudspeaker system **130** which is preferably less than or equal to the mounting area of driver **14**. The mounting area may be up to about three times greater than the coupler opening area of the acoustic coupler **142**.

A ring frame **148** is provided to support the passive radiator **16** and the upper end **150** of acoustic coupler **142**. As best seen in FIGS. **5** and **6**, the ring frame **148** comprises an outer wall **152** with an outer ledge **154**, and an inner wall **156** having an inner ledge **158** which are connected by a base plate **160**. The outer roll **108** of passive radiator **16** is mounted by adhesive or fasteners to the outer ledge **154** of ring frame **148**, and the inner roll **110** is similarly mounted to the inner ledge **158**. Fasteners **96** connect the outer ledge **154** to the front panel **20** of speaker enclosure **12**, and the upper end **150** of acoustic coupler **142** is mounted by fasteners **96** to the inner ledge **158**.

The driver **14**, passive radiator **16** and acoustic coupler **142** of the loudspeaker system **130** illustrated in FIGS. **4-6** are preferably oriented concentric to one another. However, as with the system **10** described in connection with a discussion of FIGS. **1-3**, the loudspeaker system **130** of this embodiment will function if such components are "generally concentric" to each other as that term is defined above. Additionally, the mounting structure or flange **40** of driver **14** lies in a plane **41** (horizontally oriented as depicted in the Figs.) which is spaced from the passive radiator **16** and the front panel **20** of speaker enclosure **12** where it is mounted.

Referring now to FIGS. **7** and **8**, a still further alternative embodiment of a loudspeaker system **162** according to this invention is illustrated. The loudspeaker system **162** employs the same speaker enclosure **12**, driver **14**, passive radiator **16** and ring frame **148** described above in connection with a discussion of the systems **10** and **130** shown in FIGS. **1-6**, and the same reference numbers are used in FIGS. **7** and **8** to denote like structure in such Figs. Further, the terms "mounting area," "mounting diameter," "mounting structure" and "generally concentric" defined above with reference to FIGS. **1-3** apply equally to the loudspeaker system **162**. The primary differences between loudspeaker systems **130** and **162** is that the orientation of the driver **14** is reversed, i.e. in the loudspeaker system **130** the sound-radiating surface of the diaphragm **48** of the driver **14** faces the panel opening **34** in front panel **20**, whereas in the loudspeaker system **162** the diaphragm **48** faces the back panel **22** of enclosure **12**.

The driver **14** is connected to a support bracket **164** having a lower ring **166** and an upper ring **168**. The lower ring **166** of support bracket **164** is mounted by fasteners **96** to the back wall **22** of speaker enclosure **12**. The upper ring **168** supports the flange **40** of driver frame **36**, the outer edge **72** of upper suspension **44** and the bottom end **170** of the wall **172** of an acoustic coupler **174**. A top end **175** of the acoustic coupler **174** is connected by fasteners **96** to the inner ledge **158** of ring frame **148**. Preferably, the wall **172** has a mouth or annular portion **176** which forms a coupler opening **178** denoted in FIG. **7** by a horizontal line spanning the annular portion **176**. The annular portion **176** is substantially vertically oriented and the coupler opening **178** it defines is preferably generally concentrically disposed relative to the panel opening **34** in the front panel **20** of enclosure **12** and relative to the mounting structure or flange **40** of the driver **14**. The cross sectional area of the coupler opening **178** defined by its annular portion **176** comprises the "coupler opening area" of the loudspeaker system **162** which is preferably less than or equal to the mounting area of driver **14**. The mounting area may be up to about three times greater than the coupler opening area of the acoustic coupler **174**.

The driver **14**, passive radiator **16** and acoustic coupler **174** of the loudspeaker system **162** illustrated in FIGS. **7** and **8** are preferably oriented concentric to one another. However, as with the system **10** described in connection with a discussion of FIGS. **1-3**, the loudspeaker system **162** will function if such components are "generally concentric" to each other as that term is defined above. Additionally, the mounting structure or flange **40** of driver **14** lies in a plane (horizontally oriented as depicted in the Figs.) which is spaced from the passive radiator **16** and the front panel **20** of speaker enclosure **12** where it is mounted.

While the invention has been described with reference to a preferred embodiment, it should be understood by those skilled in the art that various changes may be made and equivalents substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

What is claimed is:

**1**. A loudspeaker system, comprising:

an enclosure having a number of panels interconnected to form an interior, a first panel of said enclosure being formed with a panel opening;

a passive radiator having a central opening and a double suspension comprising an outer roll and an inner roll, said passive radiator being connected to said first panel at said panel opening therein;

a driver having mounting structure which defines a mounting area, said driver being mounted within said interior of said enclosure such that said mounting structure is located in a plane which is spaced from said first panel;

an acoustic coupler connected between said passive radiator and said driver, said acoustic coupler including a wall having a coupler opening which defines a coupler opening area, said coupler opening area being less than or equal to said mounting area.

**2**. The loudspeaker system of claim **1** in which said double suspension is connected to a tuning block.

**3**. The loudspeaker system of claim **2** in which said double suspension includes a ring between said inner and outer rolls.

**4**. The loudspeaker system of claim **3** in which said tuning block is mounted to said ring.

**5**. The loudspeaker system of claim **3** in which said wall of said acoustic coupler is mounted to said inner roll of said double suspension.

**6**. The loudspeaker system of claim **1** in which said wall of said acoustic coupler comprises an inner wall joined to an outer wall, said outer wall being connected to said first panel of said enclosure.

**7**. The loudspeaker system of claim **6** in which said inner wall includes a generally annular portion which forms said coupler opening having a cross sectional area, said cross sectional area of said coupler opening defining said coupler opening area.

**8**. The loudspeaker system of claim **1** in which said mounting area of said driver is up to about three times greater than said coupler opening area of said acoustic coupler.

**9**. The loudspeaker of claim **1** in which said driver includes a frame, said mounting structure of said driver comprising at least one flange joined to said frame.

**10**. The loudspeaker of claim **1** in which said driver is suspended within said hollow interior of said enclosure by said acoustic coupler.

**11**. The loudspeaker of claim **1** in which said enclosure includes a second panel opposite said first panel, said loudspeaker system further including a support bracket having first and second ends, said first end being connected to said second panel and said second end being connected to said driver and to said acoustic coupler.

**12**. The loudspeaker of claim **11** in which said driver includes a diaphragm, said driver being mounted to said support bracket so that said diaphragm faces said first panel of said enclosure.

**13**. The loudspeaker of claim **11** in which said driver includes a diaphragm, said driver being mounted to said support bracket so that said diaphragm faces said second panel of said enclosure.

**14**. The loudspeaker of claim **11** further including a ring frame mounted to said first panel of said enclosure at said panel opening therein, said passive radiator being connected to said ring frame.

**15**. The loudspeaker of claim **14** in which said acoustic coupler is connected between said ring frame and said support bracket.

**16**. A loudspeaker system, comprising:

an enclosure having a number of panels interconnected to form an interior, said enclosure including a first panel formed with a panel opening and a second panel located opposite said first panel;

an acoustic coupler including a wall having an inner section and an outer section, said outer wall being connected to said first panel, said inner section forming a coupler opening which defines a coupler opening area;

a passive radiator having a central opening and a double suspension comprising an outer roll and an inner roll, said passive radiator being connected to at least one of said inner and outer sections of said acoustic coupler at said panel opening in said first panel;

a driver having mounting structure which defines a mounting area, said driver being connected to at least one of said inner and outer sections of said acoustic coupler within said interior of said enclosure such that said mounting structure is located within a plane which is spaced from said passive radiator, said coupler opening area being less than or equal to said driver mounting area.

**17**. The loudspeaker system of claim **16** in which said inner and outer sections of said wall of said acoustic coupler are joined together, said mounting structure of said driver being connected to said acoustic coupler at the juncture of said inner and outer sections.

**18**. The loudspeaker system of claim **16** in which said inner section of said acoustic coupler includes a generally annular portion which forms said coupler opening having a cross sectional area, said cross sectional area of said coupler opening defining said coupler opening area.

**19**. The loudspeaker system of claim **16** in which said mounting area is up to about three times greater than said coupler opening area of said acoustic coupler.

**20**. The loudspeaker of claim **16** in which said driver includes a frame, said mounting structure of said driver comprising at least one flange joined to said frame.

**21**. A loudspeaker system, comprising:

an enclosure having a number of panels interconnected to form an interior, said enclosure including a first panel formed with a panel opening and a second panel located opposite said first panel;

a passive radiator having a central opening and a double suspension comprising an outer roll and an inner roll, said passive radiator being connected to said first panel at said panel opening therein;

a support bracket having first and second ends, said first end being mounted to said second panel;

a driver having mounting structure which defines a mounting area, said mounting structure being connected to said second end of said support bracket and being located in a plane which is spaced from said passive radiator;

an acoustic coupler connected between said passive radiator and said second end of said support bracket, said acoustic coupler including a wall having a coupler opening area, said coupler opening area being less than or equal to said mounting area.

**22**. The loudspeaker of claim **21** in which said driver includes a diaphragm, said driver being mounted to said support bracket so that said diaphragm faces said first panel of said enclosure.

**23**. The loudspeaker of claim **21** in which said driver includes a diaphragm, said driver being mounted to said support bracket so that said diaphragm faces said second panel of said enclosure.

**24**. The loudspeaker of claim **21** further including a ring frame mounted to said first panel of said enclosure at said panel opening therein, said passive radiator being connected to said ring frame.

**25**. The loudspeaker of claim **24** in which said acoustic coupler is connected between said ring frame and said support bracket.

**26**. The loudspeaker of claim **21** in which said driver includes a frame, said mounting structure of said driver comprising at least one flange joined to said frame.

**27**. A loudspeaker system, comprising:

an enclosure having a number of panels interconnected to form an interior, a first panel of said enclosure being formed with a panel opening;

a passive radiator having a central opening and a double suspension comprising an outer roll and an inner roll, said passive radiator being connected to said first panel at said panel opening therein;

a driver having mounting structure which defines a mounting area, said driver being located within said interior of said enclosure such that said mounting structure is generally concentric to said passive radiator;

an acoustic coupler connected between said passive radiator and said driver, said acoustic coupler including a wall having a coupler opening which defines a coupler opening area, said coupler opening area being less than or equal to said mounting area.

**28**. The loudspeaker of claim **27** in which said enclosure includes opposed side panels, opposed end panels, a back panel and said first panel is a front panel, said mounting structure of said driver defining a mounting diameter, said passive radiator having a central axis and said driver having a central axis.

**29**. The loudspeaker of claim **28** in which said generally concentric orientation of said mounting structure of said driver relative to said passive radiator comprises offsetting said driver from said passive radiator in a direction between said opposed side panels or in a direction between said opposed end panels in an amount within one mounting diameter of said driver.

**30**. The loudspeaker of claim **28** in which said generally concentric orientation of said mounting structure of said driver relative to said passive radiator comprises positioning said driver with respect to said passive radiator such that said central axis of said driver is angled relative to said central axis of said passive radiator.

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